

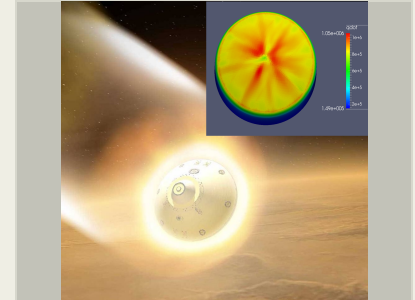
## Advanced Reentry Aeroheating Simulation Framework, Phase I

Completed Technology Project (2016 - 2016)



## Project Introduction

Vehicle reentry presents numerous challenges that must be carefully addressed to ensure the success of current and future space exploration missions. As they enter the atmosphere, these vehicles are subjected to extreme hypersonic environments typified by large structural loads, high heat fluxes and temperatures, and an aggressive aerothermal environment where nonequilibrium dissociated gases may cause chemical ablation at the vehicle's surface. These hypersonic flows involve highly nonlinear fluid-thermal interactions such as very strong shocks, high aeroheating, and shock boundary layer interactions. The extreme environments result in nonlinear, coupled interactions between the vehicle's structure and the environment. Traditionally, designs of reentry vehicles and their components have been analyzed by different engineering disciplines in an uncoupled manner, leading to a simplified superposition of different independent analyses. Depending on the assumptions, this can potentially lead to overconservatism or omission of multiphysics phenomena such as the deformation of structural skin panels which alters the local flow field and results in higher aerodynamic and heat loading. To alleviate these problems, ATA Engineering proposes to develop an innovative approach utilizing an existing multiphysics framework that enables a more complete simulation of the aeroheating environment throughout the flight trajectory in the continuum regime is proposed. In Phase I, we will demonstrate feasibility of solving these problems in ATA's multiphysics simulation environment by coupling CHAR (a 3D, implicit charring ablator solver), Loci/CHEM (a computational fluid dynamics solver for highspeed chemically reacting flows), and Abaqus (a commercial nonlinear structural dynamics package) to create a fully coupled aerothermoelastic charring ablative solver. Phase II will involve enhancements to enable full trajectory simulation and tool validation with experimental data.



Advanced Reentry Aeroheating Simulation Framework, Phase I

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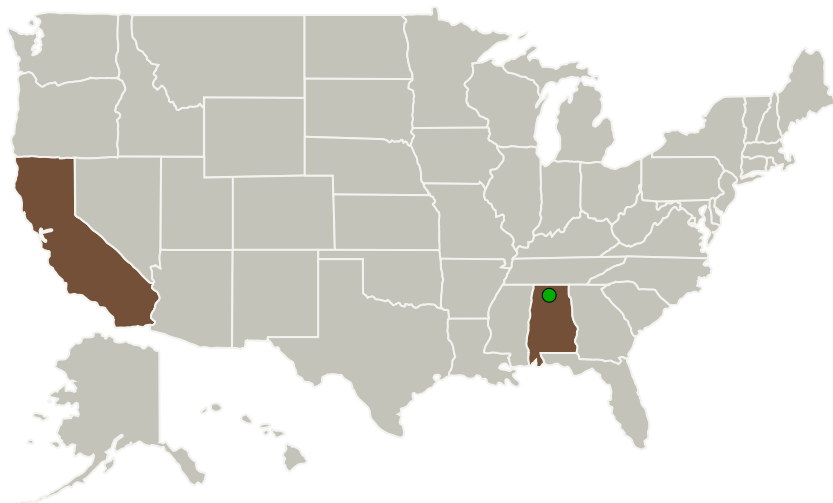
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## Advanced Reentry Aeroheating Simulation Framework, Phase I

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
ATA Engineering, Inc.	Lead Organization	Industry	San Diego, California
● Marshall Space Flight Center (MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

## Primary U.S. Work Locations

Alabama	California
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## Project Transitions

▶ **June 2016:** Project Start

✓ **December 2016:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139583>)

## Organizational Responsibility

## Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

## Lead Organization:

ATA Engineering, Inc.

## Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

## Program Director:

Jason L Kessler

## Program Manager:

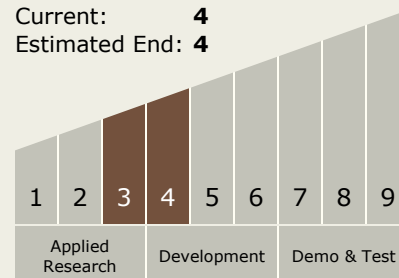
Carlos Torrez

## Principal Investigator:

Eric Blades

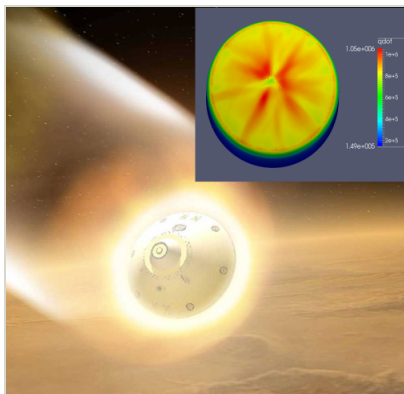
## Technology Maturity (TRL)

Start: **3**  
Current: **4**  
Estimated End: **4**





## Images



### Briefing Chart Image

Advanced Reentry Aeroheating Simulation Framework, Phase I  
(<https://techport.nasa.gov/image/133898>)



### Final Summary Chart Image

Advanced Reentry Aeroheating Simulation Framework, Phase I  
Project Image  
(<https://techport.nasa.gov/image/135702>)

## Technology Areas

### Primary:

- TX14 Thermal Management Systems
  - └ TX14.3 Thermal Protection Components and Systems
    - └ TX14.3.3 Thermal Protection Analysis

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System